UNIVERSITI PUTRA MALAYSIA

BREAKING OF DORMANCY AND MULTIPLE SHOOT FORMATION OF CURCUMA CORDATA

MUHAMMAD RIDWAN

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MASTER OF AGRICULTURAL SCIENCE
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BREAKING OF DORMANCY AND MULTIPLE SHOOT FORMATION OF *Curcuma cordata*

BY

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Agricultural Science

October 2003

Dedicated to:

My Father Sulaiman Yahya Ismail

My Mother Misraini Polem

My wife Rahmah Fitri

My Sister Laili Rahmita

My Brother Muhammad Syahputra

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Agricultural Science

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October 2003

Chairman: Associate Professor Dr. Mahmud Tengku Muda Mohamed

Faculty : Agriculture

This study was to determine the effects of different plant growth regulators (PGRs) on breaking of dormancy and induction of multiple shoot formation from rhizomes of *Curcuma cordata*. This study comprised of four experiments. The first experiment was conducted to evaluate the effect of different PGRs at various concentrations on breaking of dormancy of rhizomes of *C. cordata*. The PGRs used were IBA (0, 250, 500 and 750 mgL^{-1}), GA_3 (0, 500, 1000 and 1500 mgL^{-1}), BAP (0, 100, 200 and 300 $mgL^{-1)}$, ethephon (0, 250, 500 and 750 mgL^{-1}) and daminozide (0, 500, 1000 and 1500 mgL^{-1}). The second experiment analyzed the influence of light intensity and 6-benzylaminopurine (BAP) on breaking of dormancy of *C. cordata*. The light intensities were: 18 $\mu molm^{-2}s^{-1}$, 9.3 $\mu molm^{-2}s^{-1}$, 4.4 $\mu molm^{-2}s^{-1}$, 2.4 $\mu molm^{-2}s^{-1}$, 1 $\mu molm^{-2}s^{-1}$ and 0 $\mu molm^{-2}s^{-1}$, respectively. The third experiment analyzed the effect of different PGRs with sucrose at various concentrations on breaking of dormancy of rhizomes of *C. cordata*. The

PGRs used were IBA, GA_3, BAP, ethephon and daminozide at the concentrations of 0, 50 and 100 mgL^{-1} respectively and the concentrations of sucrose were 0, 40, 80 gL^{-1} respectively. The fourth experiment analyzed the effect of BAP on multiple shoot formation at various concentrations (0, 0.5, 1, 2, 4 and 8 mgL^{-1}).

The results indicated that BAP at 100 mgL^{-1} was able to break the dormancy in rhizomes of *C. cordata*. Emergence of shoots from the rhizomes proved this experiment. IBA GA_3 and ethephon were also able to break the dormancy, however the shoots produced were less. Daminozide had no significant effect on breaking of dormancy of *C. cordata*. Light intensity had significant effect on breaking of dormancy, percentage of rooting, shoot length, fresh weight, dry weight and diameter of shoots. The highest percentage of shoots was obtained under light intensity of 4.4 $\mu molm^{-2}s^{-1}$. The maximum shoot length was obtained under light intensity of 1$\mu molm^{-2}s^{-1}$. Interaction between plant growth regulators and sucrose gave satisfactory result. Interaction of plant growth regulators and sucrose resulted in the highest percentage of shoot formation at BAP 100 mgL^{-1} and sucrose at 40 gL^{-1}. The same combination also caused high rooting and increased shoot diameter. BAP treatments at various concentrations were also able to produce multiple shoot formation. A bud could produce 4 to 5 shoots within 5 to 6 weeks. The highest number of multiple shoot formation was obtained with BAP concentration of 4 mgL^{-1}. High concentration of BAP at 8 mgL^{-1} inhibited the initiation of shoots.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sain Pertanian

PEMECAHAN KEDORMANAN DAN PENGGANDAAN TUNAS DARI *Curcuma cordata*

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Kajian ini telah dijalankan dengan objektif untuk mengetahui kesan pelbagai hormon penggalak tumbesaran tumbuhan dengan pelbagai kepekatan yang berbeza dalam pemecahan dormansi dan memperolehi pengeluaran tunas dari rizom *Curcuma cordata*. Penggalak tumbesaran yang di gunakan ialah IBA (0, 250, 500, 750 mgL^{-1}), GA_3 (0, 500, 1000, 1500 mgL^{-1}), BAP (0, 100, 200, 300 mgL^{-1}), ethephon (0, 250, 500, 750 mgL^{-1}) dan daminozide (0, 500, 1000, 1500 mgL^{-1}). Kajian kedua pula mengkaji kesan cahaya dan BAP keatas pemecahan kedormanan daripada rizom *C. cordata*. Cahaya yang digunakan terdiri dari 6 paras iaitu kawalan, 18 $\mu molm^{-2}s^{-1}$ (diperolehi dari botol jem tiada dibungkus jaring), 9.3 $\mu mol\ m^{-2}s^{-1}$ (dibungkus 1 lapis jaring hitam, 4.4 $\mu molm^{-2}s^{-1}$ (dibungkus 2 lapis jaring hitam), dan cahaya 2.4 $\mu molm^{-2}s^{-1}$ (dibungkus 3 lapis jaring hitam), cahaya 1 $\mu molm^{-2}s^{-1}$ diperolehi

dari botol jem dibungkus 4 lapis jaring hitam dan 0 $\mu molm^{-2}s^{-1}$ dibungkus kain hitam. Kajian ketiga pula mengkaji kesan interaksi antara penggalak tumbesaran tumbuhan dengan sukros pada kepekatan yang berbeza untuk mengetahui kesannya ke atas pemecahan dormansi dari rizom *C. cordata*. Penggalak tumbesaran yang digunakan ialah IBA, GA_3, BAP, ethephon dan daminozide masing-masing pada kadar 50, 100 mgL^{-1} dan kawalan dan sukros pada kepekatan 40, 80 gL^{-1} dan kawalan. Kajian ke empat pula mengkaji kesan BAP ke atas penggandaan tunas dari rizom *C. cordata* pada kadar yang berbeza iaitu 0, 0.5, 1, 2, 4 dan 8 mgL^{-1}.

Keputusan yang diperolehi menunjukkan bahawa BAP pada kepekatan 100 mgL^{-1} berjaya memecahkan kedormanan pada rizom *C. cordata.* Ini ditunjukkan dengan banyaknya tunas yang keluar dari rizom. Manakala IBA dan GA_3 juga berjaya memecahkan kedormanan tetapi tidak sebanyak BAP. Walaubagaimanapun Daminozide tiada menunjukkan kesan ke atas pemecahan kedormanan risom *C. cordata*. Manakala kesan cahaya keatas pemecahan kedormanan ialah menunjukkan kesan yang bererti, rawatan ini berjaya memperolehi peratus tunas yang tinggi, Cahaya yang baik untuk pemecahan kedormanan diperolehi pada intensitas 4.4 $\mu molm^{-2}s^{-1}$, pada kajian ini juga diperolehi tinggi tunas yang maksima iaitu pada cahaya 1 $\mu molm^{-2}s^{-1}$. Interaksi antara penggalak tumbesaran tumbuhan dan sukros menunjukkan perbezaan yang bererti. Manakala interaksi kedua rawatan ini menunjukkan peratus tunas yang tinggi iaitu BAP pada kepekatan 100 mgL^{-1} dan sukros 40 gL^{-1} dan menunjukkan diameter tunas yang besar. Rawatan BAP pada kepekatan yang berbeza juga mampu menghasilkan

penggandaan empat sehingga lima tunas daripada satu tunas. Masa yang diperlukan untuk memperolehi empat sehingga lima tunas ialah lima sehingga enam minggu. Rawatan BAP yang baik ialah pada kepekatan 4 mgL^{-1}. Kepekatan BAP yang tinggi pada 8 mgL^{-1} diberikan akan merencat dan membantutkan pertumbuhan tunas *C. cordata*.

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I certify that an Examination Committee met on October 10, 2003 to conduct the final examination of Muhammad Ridwan on his Master of Agriculture Science thesis entitled "Breaking of Dormancy and Multiple Shoot formation of *Curcuma cordata*" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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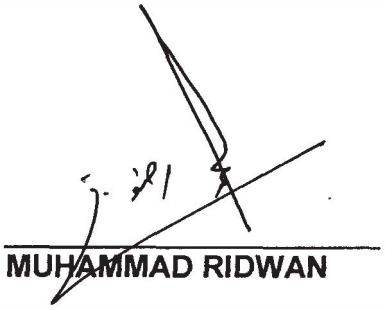
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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LIST OF ABBERVIATIONS

°C	degree celsius
ANOVA	analyses of variance
BAP	6-benzylaminopurine
Cm	centimeter
DMRT	Duncan's Multiple Rage Test
DAC	day after culture
Et al	et alia
GA	gibberellic acid
g	gram
h	hour
HCl	hydroxyl chloride
HgCl2	mercury chloride
IBA	indole-3-butyric acid
KOH	kalium hydroxide
gL^{-1}	gram perliter
mgL^{-1}	milligram per liter
mm	millimeter
mM	milimolar
μ mol m^{-2} s^{-1}	micromole per meter square per second
MS	inorganic nutrient composition of Murashige and Skoog (1962)

PGRs	plant growth regulators
ppm	part per million
p=0.05	probability at 95 %
RCBD	randomized complete block design
SAS	statistical analysis system
%	percent

CHAPTER 1

INTRODUCTION

The floriculture industry has been one of the rising stars in the Malaysian agriculture. While this sector is small compared with the larger sectors like oil palm and chicken rearing, it has grown rapidly from virtual non-existence just a few years ago. The industry involves not only the production of cut flowers (orchids and non orchids), but also the production of flowering plants, foliage and propagation materials. The most popular flower is chrysanthemum followed by roses and esters. As a result, Malaysian orchid exports drooped in each years, but temperate flowers is on the increase (Anonymous, 2002). *Curcuma* has beautiful flowers and can be used as food and medical plants, it is becoming more important due to the rising Malaysian exports.

The *Curcuma* is one of the genera in the family Zingiberaceae and order Zingiberales, which forms an isolated group among the monocotyledons. A family of about 47 genera and 1400 species of which about 1000 species can be found in tropical Asia (Larsen *et al*., 1999). The richest area is the Malaysia region, a floristically distinct region that includes Burma, Indonesia, Malaysia, Singapore, Papua New Guinea and Philippines, with 24 genera and about 600 species. Several species of Zingibereceae are use as spices, medicines, flavoring agents, dyes and ornamentals or quite

recently as cut flowers and landscape plants (Bhagyalakshmi *et al*., 1994; Larsen *et al*., 1999).

Curcuma is usually a small to medium-sized herb with fleshly rhizomes and tuber bearing roots. The flowers are usually of colors different from the bracts. The upper corolla lobe and the staminodes overlap, forming a hooded structure, while the lip is rather short with upcurved margins (Larsen, *et al*., 1999)

The climate of peninsular Malaysia allows continuous growth of the rhizomes throughout the year although more vigorous growth may be apparent during the rainy season. Nevertheless, in some genera like *Curcuma, Kaempferia* and *Globba*, in which cases the rhizomes are more or less fleshy, the rhizomes remain dormant for a certain period of time especially during the dry season. The effect of dormancy inhibited the emergence of bud for a certain length of period. Rukmana (1995) reported that dormancy of *Curcuma* could reach a period of 1-2 months.

Breaking of dormancy in *Curcuma* is a major problem in its propagation. Dormancy is caused by innate factors such as natural property of the plant and low water content of the rhizomes or due to external factors such as temperature and day length. Dormancy has major biological interest and an understanding whether it is by environmental and hormonal or other biochemical factors has been sought for years. Treating with plant growth regulators was found to be able to break the dormancy. Chemical treatments